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(54) Title: VEHICLE NAVIGATION SYSTEM
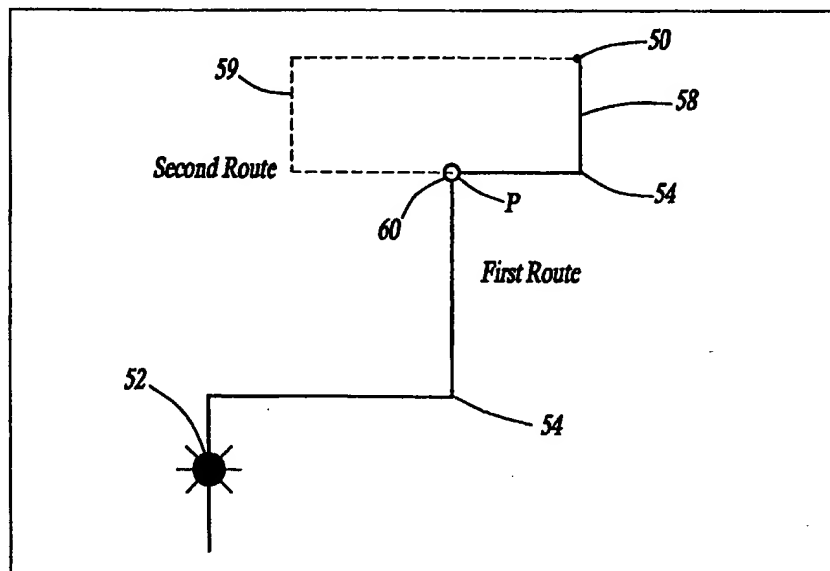
(57) Abstract

A navigation system calculates a first route to a first destination. If the navigation system determines while en route that a second route would result in a significant time saving, the navigation system selects a point along the first route between the current vehicle location and the first destination as a new "origin" for the second route. The navigation system guides the user to the intermediate point along the first route. The navigation system then guides the user from the intermediate point along the second route. The second route can be an alternate route to the same destination or an alternate route to a second destination.

VEHICLE NAVIGATION SYSTEM

BACKGROUND OF THE INVENTION

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The present invention relates generally to navigation systems and more specifically to an improved navigation system for calculating an alternate route.

Navigation systems generally provide a recommended route from an origin to a desired destination. Generally, the origin and desired destination are selected from a large database of roads stored in a mass media storage device, such as a CD ROM, which includes the roads in the area to be traveled by the user. The navigation system typically includes one or more position determining devices, such as a GPS (Global Positioning System) receiver, which indicates the current position of the vehicle relative to the database. The navigation system typically defines the current vehicle location as the origin for calculating a route. The navigation system then determines a route from the origin to the desired destination utilizing algorithms well-known to those in the art and currently in use in many navigation systems. The navigation system selects a recommended route from the origin to the desired destination based upon "cost" values associated with each segment of road in the road database, such as the estimated time of travel through the road segment. The navigation system determines the route with the lowest total estimated time of travel to the desired destination. The recommended route is then displayed to the user as a map showing the origin and desired destination and highlighting the recommended route. The navigation system then displays the current position of the vehicle and turn-by-turn instructions to the driver, guiding the driver to the desired destination.

If the navigation system also includes a receiver for receiving information relating to traffic congestion of certain road segments, the navigation system recalculates the estimated times of travel for the road

segments and may determine that an alternate route would be preferable. Similarly, while en route to a first desired destination, a driver may decide instead to travel to a second destination. In either situation, because the known navigation systems utilize the current vehicle location as the origin, the vehicle is no longer at the origin by the time the route is calculated and then displayed to the driver . As a result, the driver may have already missed an initial maneuver or may be tempted to attempt a rushed maneuver. This causes not only obvious safety concerns but also causes anxiety and discomfort to the driver utilizing the navigation system.

SUMMARY OF THE INVENTION

The present invention provides a navigation system which selects a point on the first recommended route as an "origin" for the second recommended route. The navigation system includes a CPU, a database of roads to be travelled by the user, position-determining devices, and a user input device.

The navigation system calculates a first route according to known algorithms to a first selected destination. As the navigation system guides the driver turn-by-turn toward the first destination along the first recommended route, there are situations where the navigation system of the present invention calculates a second recommended route. In such situations, the point selected as the "origin" for the second recommended route is an intermediate point lying on the first route between the current vehicle location and the first destination. Depending upon whether the vehicle is travelling a highway or sidestreet, the actual or expected speed of the vehicle, and what type of initial maneuver is required, the intermediate point is selected to give the driver the necessary lead time to make the initial maneuver onto the second recommended route.

One situation where a second recommended route is calculated by the navigation system is where the second recommended route is an alternate route

to the first destination which avoids a congested road segment. Another
situation is where the second route also leads to a second destination rather
than the first destination, such as when the driver decides to travel to the
second destination while en route to the first destination.

BRIEF DESCRIPTION OF THE DRAWINGS

The above, as well as other advantages of the present invention, will
become readily apparent to those skilled in the art from the following detailed
description of a preferred embodiment when considered in the light of the
accompanying drawings in which:

Figure 1 is a schematic of the navigation system of the present
invention installed in a vehicle;

Figure 2 is a screen of the display of the navigation system of Figure
1;

Figure 3 is a representation of the method of determining the second
route to the first destination by the navigation system of Figure 1;

Figure 4 is a representation of the method of determining the second
route to a second destination by the navigation system of Figure 1.

DESCRIPTION OF A PREFERRED EMBODIMENT

The navigation system 20 of the present invention is shown
schematically in Figure 1. The navigation system 20 includes a CPU 22
connected to a display 24, such as a high resolution LCD or flat panel display.
The CPU is also connected to a input device 26 such as a mouse, keyboard,
keypad or remote device. Alternatively, the display 24 can be a touch screen
display. The navigation system 20 further includes a database 28 connected
to the CPU 22. The database 28 is a mass media storage device, such as a
CD ROM, which includes a map of all of the roads in the area to be traveled
by the user. Each road in the database is divided into road segments, each

having an associated set of cost values, which indicate the "cost" of traveling that road segment. For example, the cost values include the estimated time of travel on the road segment and current traffic congestion level.

5   The navigation system 20 is preferably installed in a vehicle 32. The navigation system 20 preferably includes position determining devices, such as a GPS system 34, a gyroscope 36, a compass 38, and a wheel speed sensor 40, all connected to the CPU 22 [connections not shown for simplicity]. Such position determining devices are well known and are commercially available. The navigation system further includes a congestion data receiver 42, such as

10   a radio receiver, for receiving up-to-date broadcast information regarding traffic congestion levels of area road segments. Congestion monitoring devices are known and are currently used to automatically monitor the congestion levels of certain road segments. Preferably, information gathered from the congestion monitoring devices is broadcast to the surrounding area

15   and received by the congestion data receiver 42. The data receiver 42 sends the congestion information to the CPU 22, which stores the updated congestion information. As shown in Figure 2, the navigation system 20 guides the driver to a selected destination with turn-by-turn instructions shown on the display 24.

20   Referring to Figure 3 the driver of the vehicle 32 preferably selects a destination 50 relative to the database 28 and inputs the destination 50 to the CPU 22 utilizing the input device 26. Usually the vehicle's current location as determined by the position determining devices is selected as a first origin 51 relative to the database 28. The CPU 22 then calculates a first route 54

25   from the first origin 51 to the destination 50. While travelling the first route 54, the position determining devices continuously calculate the current vehicle location 52 relative to the database 28. If while traveling the first route 54, the CPU 22 receives congestion data from the congestion data receiver 42, indicating that a road segment 58 is congested, the CPU 22 selects as a new

30   "origin" point 60 which is a point lying along the first route 54 between the

current vehicle location 52 and destination 50. The CPU 22 then calculates a second route 59 to the destination 50 which avoids road segment 58.

The distance between the current vehicle location 52 and the intermediate point 60 is preferably optimized to give the driver of the vehicle

5   32 sufficient time to make the initial maneuver where the driver of the vehicle 32 would deviate from the first route 54 to the second route 59. The distance depends upon the type of road being travelled, such as a highway or sidestreet, the current or expected vehicle speed, and the complexity and type of initial maneuver onto the second route 59. The CPU 22 then guides the driver of the

10   vehicle 32 along first route 54 until reaching intermediate point 60, where CPU 22 guides the driver of the vehicle 32 along the second route 59 to the destination 50 by displaying turn-by-turn instructions on display 24.

Preferably, the CPU 22 first determines whether the second route 59 will result in a significant reduction in time from the first route 54 before

15   recommending the second route 59. For example, the CPU 22 only recommends the second route 59 if it results in a 20 percent reduction in travel time, where the reduction is no less than five minutes. If these criteria are met, the CPU 22 beeps to get the attention of the driver while displaying a new screen offering the second, quicker route. The CPU 22 then provides the

20   driver of the vehicle 32 with the option of selecting the second route 59. Preferably, a voice informs the driver that the first recommended route 54 contains traffic congestion and inquires whether the driver would prefer a second recommended route 59 which would result in a significant time reduction. The CPU 22 also indicates the estimated time savings for the

25   second route 59 to assist the driver's decision. If the driver does not choose the quicker route within a certain time period, the CPU 22 will continue to guide the driver of the vehicle 32 along the first route 54. The CPU 22 preferably does not offer a route improvement to the driver more often than once every five minutes. The driver of the vehicle 32 can enable or disable

30   the presentation of route improvements based upon traffic information.

The operation of the navigation system 20 of the present invention is also demonstrated in Figure 4. The driver of the vehicle 32 preferably selects a first destination 70 from the database 28. As described above, and as is well-known, the CPU 22 calculates a first route 74 from a first origin 71 to

5   the first destination 70. The position determining devices continuously determine the current vehicle location 72. If, while en route to the first destination 70, the driver of the vehicle 32 decides to travel to a second destination 76 rather than the first destination 70, the CPU 22 selects an intermediate point 78 which lies along the first route 74 between the current

10   vehicle location 72 and the first destination 70. The CPU 22 then calculates a second route 80 from the intermediate point 78 to the second destination 76. The CPU 22 guides the vehicle 32 along the first route 74 to the intermediate point 78 and from the intermediate point 78 along the second route 80 to the second destination 76.

15   When recommending a change in the route for any reason, the navigation system 20 of the present invention selects a second "origin", intermediate point 60, 78, between the current location 52, 72 and the first destination 70, 50. The navigation system 20 provides sufficient distance between the current location 52, 72 and the intermediate point 60, 78 such that

20   the initial maneuver onto the second route 76, 59 will not be missed or rushed. This reduces safety concerns and reduces driver anxiety when the recommended route is changed. It should be recognized that the navigation system 20 of the present invention would be used in other situations where a second route is calculated and recommended to the driver. Two examples of

25   such situations have been described here, i.e. providing guidance along a second route 80 to a second destination 76 or along an alternate route 59 to a first destination 50.

In accordance with the provisions of the patent statutes, the present invention has been described in what is considered to represent its preferred

30   embodiment. However, it should be noted that the invention can be practiced

otherwise than as specifically illustrated and described without departing from its spirit or scope.

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WHAT IS CLAIMED IS:

1. A navigation system comprising:

a database of roads to be travelled by a vehicle;

5   a system for selecting a first origin relative to said database;

a user input device for selecting a first destination relative to said database;

a system for determining a first route from said database from said first origin to said first destination;

10   a system for determining the current location of the navigation system relative to said database;

a system for determining a second route from said database from a second origin on said first route between said current location and said first destination.

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2. The navigation system of Claim 1 further including a system for selecting a second destination from said database, said system for determining a second route calculating said second route from said second origin to said second destination.

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3.   The navigation system of Claim 1 wherein said system for determining a second route calculates said second route from said second origin to said first destination, said first route including a road segment not included in said second route.

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4. The navigation system of Claim 1 wherein said database includes road segments, each said road segment having an associated travel time stored in said database, said system for determining a first route utilizing said associated travel times to determine said first route.

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5. The navigation system of Claim 1 further including a system for receiving congestion information, said system for determining said first route utilizing said congestion information to calculate said first route.

6. The navigation system of Claim 1 wherein said database includes road segments, each said road segment having an associated travel time stored in said database, said system for determining a first route utilizing said associated travel times to determine said first route, said navigation system further including a system for adjusting for receiving congestion information about road segments, said system for determining a second route utilizing congestion information to determine said second route.

7. A method for planning a route including the steps of:

a) selecting a first origin relative to a database of roads;

b) selecting a first destination relative to said database of roads;

c) determining a first route from said database of roads from said first origin to said first destination;

d) determining a current location on said first route; and

e) determining a second route from a second origin lying on said first route between said current location and said first destination.

8. The method for planning a route according to Claim 7 further including the steps of:

providing guidance instructions from said first origin along said first route; and

providing guidance instructions from said second origin along said second route.

9. The method for planning a route according to Claim 7 wherein said step d) includes the steps of installing a position-determining device on a vehicle, said current location being the current location of the vehicle.

10. The method for planning a route according to Claim 7 further including the steps of:

associating an estimated travel time with each of a plurality of road segments of said roads in said database; and

5   determining said first route and said second route based upon said travel times.

11. The method for planning a route according to Claim 7 further including the steps of:

10   travelling along said first route;

selecting a second destination while travelling said first route; and

determining said second route to said second destination.

12. The method for planning a route according to Claim 7 further

15   including the steps of:

receiving traffic congestion information associated with a road segment; and

determining said second route based upon said traffic congestion information.

20

13. A method for planning a route including the steps of:

a) associating a travel time with each of a plurality of road segments in a database of roads;

b) selecting a first origin relative to said database of roads;

25   c) selecting a first destination relative to said database of roads;

d) determining a first route from said database of roads from said first origin to said first destination;

e) providing guidance instructions from said first origin along said first route;

30   f) determining a current location on said first route relative to said database of roads;

g) receiving congestion information associated with a congested road segment included in said first route;

h) determining a second route from a second origin lying on said first route between said current location and said first destination, said second route not including said congested road segment;

i) estimating the time to be saved by travelling said second route rather than said first route;

j) selecting to travel said second route rather than said first route based upon said estimated time to be saved; and

k) providing guidance instructions from said second origin along said second route.

14. A method for planning a route wherein said step k) includes the step of providing guidance instructions to said first destination.
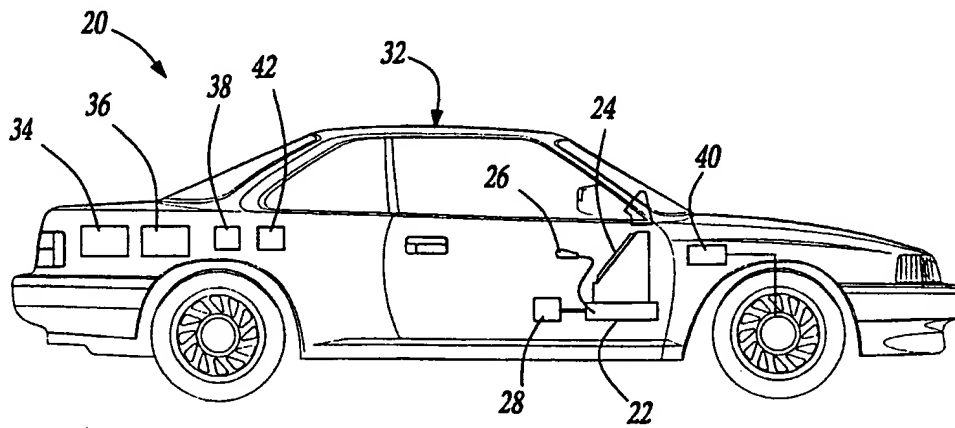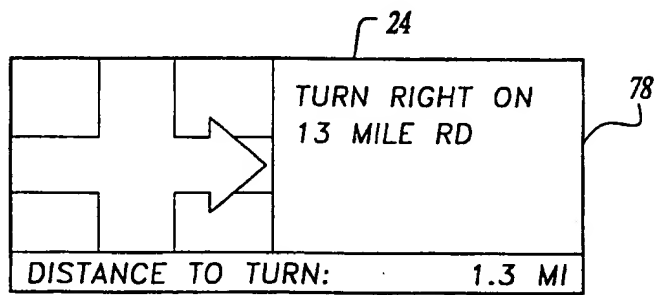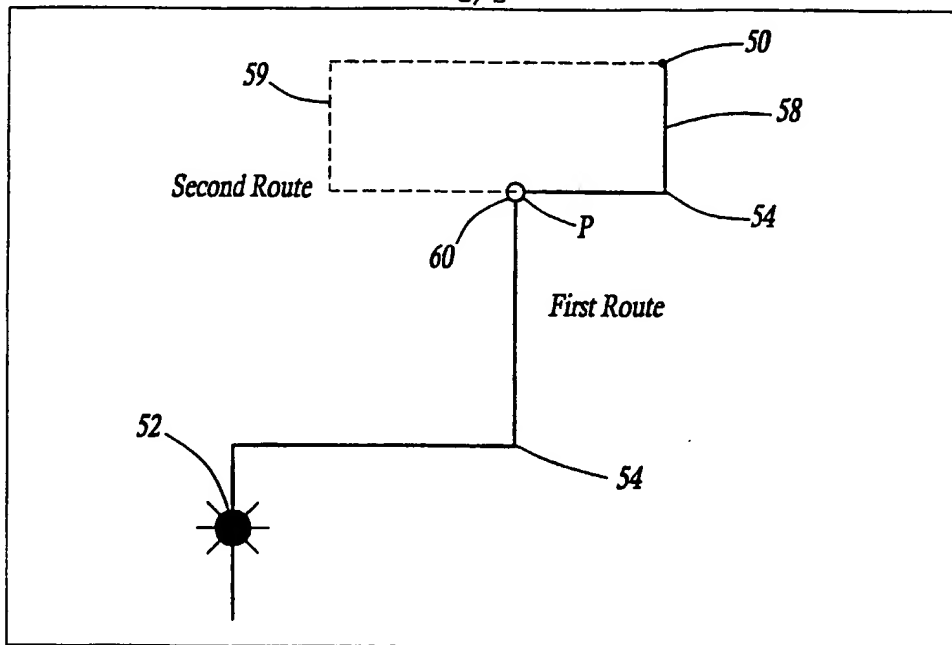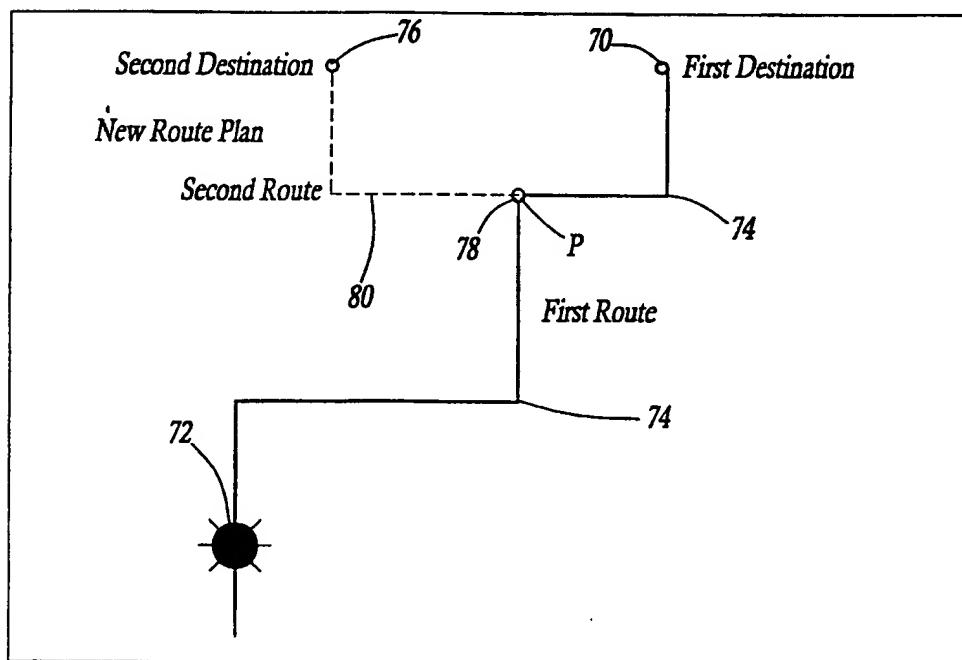
Fig-1

TURN RIGHT ON
13 MILE RD

DISTANCE TO TURN: 1.3 MI

Fig-2

2/2

Fig-3

Fig-4

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6   G01C21/20   G08G1/09

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6   G01C   G08G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category°	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 428 545 A (MAEGAWA SHOUITI ET AL) 27 June 1995	1,3-10, 12
Y	see column 1, line 33 – line 51 see column 6, line 31 – column 7, line 58; figures 6,7 ---	13,14
Y	US 5 406 490 A (BRAEGAS PETER) 11 April 1995 see column 3, line 33 – column 4, line 7 --- -/--	13,14

X	Further documents are listed in the continuation of box C.		X	Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 December 1997	09/01/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Hoekstra, F

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category°	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Inter   nal Application No

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